REVISTA DE ODONTOLOGIA DA UNESP
www.revodontolunesp.com.br
Original Article

Morse taper implant macrodesign, loading protocol and site of installation – retrospective study of 5,601 implants

Macrodesenho do implante cone Morse, protocolo de carregamento e local de instalação – estudo retrospectivo de 5601 implantes

Rafael Coutinho Mello MACHADO[a], Geninho THOMÉ[a], Sergio Rocha BERNARDES[a], Ana Claudia Moreira MELO[a]*

[a]ILAPEO – Instituto Latino Americano de Pesquisa e Ensino Odontológico, Curitiba, PR, Brasil

How to cite: Machado RCM, Thomé G, Bernardes SR, Melo ACM. Morse taper implant macrodesign, loading protocol and site of installation – retrospective study of 5,601 implants. Rev Odontol UNESP. 2019;48:e20190069. https://doi.org/10.1590/1807-2577.06919

Resumo

Introdução: O monitoramento a longo-prazo de reabilitações implantossupportadas é extremamente importante para avaliação dos parâmetros que podem interferir no sucesso do tratamento. **Objetivo:** Avaliar a influência do macrodesenho (forma do corpo e ápice), comprimento e diâmetro, torque de inserção, região de instalação, assim como o protocolo de carregamento, na sobrevivência a longo-prazo. **Material e método:** Os dados foram obtidos a partir dos prontuários de pacientes reabilitados com pelo menos um implante cone Morse na Faculdade Ilapeo entre os anos de 2006 e 2012. Prontuários com preenchimento incompleto, que pudesse interferir na coleta de dados foram excluídos da amostra. **Resultado:** Um total de 1142 prontuários compôs a amostra, resultando num total 5601 implantes, instalados tanto em mandíbula como em maxila. A taxa de sobrevivência final foi de 98,31%, em um tempo médio de 37,54 meses. O tipo de implante mais utilizado foi o cilíndrico (70,33%). O torque médio de instalação ficou entre 41 e 50 Ncm. Uma análise de regressão logística mostrou que nenhuma das seguintes variáveis, local de instalação, forma do corpo e ápice e comprimento, teve influência estatisticamente significante na perda de implantes. O aumento do torque e o diâmetro influenciaram a perda do implante e a carga imediata favoreceu a estabilidade. **Conclusão:** Pode ser concluído que implantes cone Morse apresentam índice de sobrevivência elevado que pode ser influenciado por um torque excessivo assim como pelo diâmetro do implante.

Descritores: Implantação dentária; prótese dentária; reabilitação bucal.

Abstract

Introduction: The long-term implant-supported prosthetic rehabilitation monitoring is extremely important in evaluating parameters that could interfere in the success of the treatment. **Objective:** To evaluate the influence of macrodesign (shape of the body and apex), length and diameter, insertion torque, site of installation as well as the loading protocol, on long-term survival rates. **Material and method:** The data obtained was from the medical records of rehabilitated patients who had had at least one Morse taper implant surgery done at ILAPEO School between 2006 -2012. Incomplete medical records, from which it would have been impossible to extract all data essential to complete the study, were excluded. **Result:** A total of 1,142 patient's medical records comprised the sample; documenting the progress of 5,601 implants, done in both jaws and mandibles. The final survival rate was 98.31%, over an average time of 37.54 months. The type of implant most used was cylindrical (70.33%). The mean installation torque most evidenced in the study was between 41 and 50 Ncm. A logistical regression analysis showed that none of the following variables, site of installation, body and apex shape designs and length, had any significant statistical influence on implant loss. Torque increase and diameter influenced implant loss while immediate loading

favored implant maintenance. **Conclusion:** It can be concluded that Morse taper implants present a long-term survival rate that can be lowered by excessive torque, as well as by the diameter of the implant.

Descriptors: Dental implantation; dental prosthesis; mouth rehabilitation.

INTRODUCTION

Treatment with osseointegrated implants was described in the 1960's by Brånemark and his team, who recommended that the procedure be done in two stages, and with healing periods of 3 to 6 months[1]. However, other researches[2,3] have demonstrated the possibility of even faster and predictable surgical and prosthetic restoration. In consequence, the use of osseointegrated dental implants became a common practice in oral rehabilitation, being confirmed by the high efficiency in the restoration of single, partial, or complete edentulous arches[4,5]. Nevertheless, in spite of the success of osseointegrated implants, problems both mechanical and biological, such as loosening of the abutment screw and bacterial microleakage have been documented[6-10].

The Morse taper connection was developed in 1864 by Stephen A. Morse, and in Implantology has resulted in a better fit between implant and abutment, with a reduction in gap size and less bacterial microleakage, as well as less marginal bone loss[7,11-17]. Furthermore, it minimizes pillar loosening and improves mechanical stability[7,10,11,18]. Moreover, clinical studies have been carried out showing adequate survival rates[19-22].

It has also been recommended, with the objective of maintaining peri-implant bone tissue, the utilization of prosthetic components with a diameter reduced in comparison to the implant, also known as platform switching. Lazzara, Porter[23] hypothesized that less bone resorption occurred the farther the infiltrated inflammation area was from the crest. The clinical results and high predictability of Morse taper implants associated with platform switching abutments have been widely studied[15,24,25].

With respect diameter of the implant, some are the advantages cited of using wider implants as more bone to implant contact, bicortical engagement and reduction in abutment stresses[26]. But in a systematic review the authors observed that the survival rate of small-diameter implants appears to be similar to the regular ones[27]. Considering length, Olate et al.[28] reported that early implant loss might be related to length, but not diameter.

Dental implant survival rate may also be related to the quality and quantity of bone. In a systematic review, the authors observed that the survival rate of dental implants inserted in low density bone was lower than in better quality bone[29]. But this worst result can be minimized with the choice of implant geometry in areas with low-density bone[30].

The long-term implant-supported prosthetic rehabilitation monitoring is extremely important in evaluating parameters that could interfere in the success of the treatment. Nevertheless, studies on success and survival rates of dental implants are complex because they´re influenced by a large number of variables[31]. So, the aim of this cross-sectional study was to evaluate the relationship of macrodesign parameters, area of installation, insertion torque and loading time of Morse taper connection implants with its long-term stability.

MATERIAL AND METHOD

This cross-sectional study evaluated the long-term survival rate of Morse taper implants with a target population of patients who were rehabilitated through the installation of Morse taper implants at the ILAPEO School. Guidelines proposed by the STROBE Declaration (*Strengthening the Reporting of Observational Studies in Epidemiology*) were followed.

This study was approved by the Research Ethics Committee at the International University Center – UNINTER – under the protocol number 1,484,665.

The sample consisted of consecutive rehabilitated patients between the years 2006 and 2012 in Implantology courses of Ilapeo College. The inclusion criteria were patients who had had Morse taper implant(s) supporting single, partial or full-arch prostheses during the aforementioned period. Incomplete medical records that did not have all the information necessary to complete the study were excluded.

After obtaining the list of the patients that were in accordance with the inclusion criteria listed above, the desired data were collected from their medical records through a software program called Google Form based on Cloud Computing.

The following variables were considered:

Exposure variables:

Related to the implant – diameter, length, body and apex shape (conical or cylindrical), insertion torque, and loading protocol (immediate or not);

Related to the patient – rehabilitation location (anterior or posterior region), and area (maxilla or mandible);

Outcome variables:

Implant loss;

Follow-up period.

A statistical analysis was done using Stata software 14.0 (StataCorp LLC, College Station, Texas, EUA) with an accuracy ratio of 95%. An independent statitian revised the study.

RESULT

A total of 5,601 implants (Neodent, Curitiba, Brazil) installed in 1,142 patients were included in the study. The mean follow-up period was 37.54 months (maximum 159 months). Three hundred and eighty-five medical records had inconsistencies (missing information) and were excluded.

The survival rate was 98.38% (5,510). Ninety-one implants suffered stability loss after being in function.

Considering data related to the installation location and area, 51.21% were in the maxilla. Data related to design variables and insertion torque are shown in Table 1.

Table 1. Descriptive macrogeometry data of the implants (body and apex shape), length and diameter and insertion torque

Body shape	n	Percentage
Conical (Alvim)	1447	25.83
Conical for bone types 3+4 (Drive)	195	3.48
Cylindrical (Titamax)	3939	70.33
Zygomatic	6	0.11
No Data	14	0.25
Apical Shape	**n**	**Percentage**
Conical (Alvim)	1444	25.78
Conical for bone types 3 + 4 (Drive)	193	3.45
Cortical	2834	50.60
Cylindrical with conicity at apex (EX)	844	15.07
Medular short implant (WS)	228	4.07
Cortical short implant (WS)	36	0.64
No data	22	0.39

Table 1. Continued…

Torque	n	Percentage
00-10 N	107	1.91
11-20 N	284	5.07
21-30N	285	5.09
31-40N	566	10.11
41-50N	931	16.62
51-60N	889	15.87
61-70N	176	3.14
71-80N	523	9.34
Above 80N	29	0.51
No Data	1811	32.33
Diameter	**n**	**Percentage**
3.5	1,69	30.17
3.75	2,225	39.73
4.0	933	16.66
4.3	347	6.20
5.0	400	7.14
No Data	6	0.11
Length	**n**	**Percentage**
5	106	1.89
6	61	1.09
7	270	4.82
8	440	7.85
9	567	10.12
10	261	4.66
11	823	14,69
11.5	354	6,32
12	10	0,18
13	1,647	29,39
14	7	0,12
15	604	10,78
16	228	4,07
17	201	3,59
TOTAL	5,601	100,00

Of the 5,601 implants observed in this study, 1,090 were installed with immediate loading (19.46%). Only 91 implants were lost during this study and 0.27% (3 implants) had been submitted to immediate loading.

A logistical regression test was applied to evaluate which variables influenced the implant survival rate. Parameters such as: region, body, apex shape and length did not show any significant influence on implant loss (Table 2).

Table 2. Logistical regression test of the following variables: installation area, torque, body and apex shape, implant length and diameter, as well as immediate loading

Loss	Coef.	Std. Err	z	P>|z|	[95% Conf. Interval]	
Region	.1795711	.1271204	1.41	0.082	-.069	.428
Torque	.1470422	.084532	1.74	0.082	-.018	.312
Body	-.2608763	.2997885	-0.87	0.384	-.848	.326
Apex Shape	.176352	.2038944	0.86	0.387	-.223	.575
Diameter	.8252185	.2947726	2.80	0.005	.247	1.402
Lenght	-.0556805	.0542274	-1.03	0.305	-.161	.050
Immediate loading	-166.211	.6035445	-2.75	0.006	-2.845	-.479
_cons	-7.800.781	1.488.271	-5.24	0.000	-1.071	-4.883

An increase in torque and diameter both had a direct influence on implant loss. On the other hand, immediate loading was inversely proportional implant loss, that is, it favored implant maintenance (Table 3).

Table 3. Logistical regression data on risk parameters of implant loss

Loss	Coef.	Std. Err	z	P>|z|	[95% Conf. Interval]	
Torque	.1686332	.0816743	2.06	0.039	.0085544	,328712
Diameter	.9886589	.9886589	3.73	0.000	.4688726	1.508.445
Immediate loading	-1637496	.6020643	-2.72	0.007	-281752	-,4574715
_cons	-8650609	1.181.692	-7.32	0.000	-1096.668	-6334534

DISCUSSION

The survival rate in this study, which consisted of 5,601 implants, was 98.39% with an average observation period of 37.54 months, with the longest being 11 years. This survival data is in accordance with other studies that reported for External Hexagon prosthetic implant platforms – 98.40% after one year in 64 patients with 199 implants[26], for Internal Hexagon – 98.10% after 3 years in 73 patients with 116 implants[3] and for Morse taper – 98.40% after 5 years in 377 patients with 314 implants[19]. This data demonstrates that a Morse taper platform, at the least, is equal to other types of platforms that have been on the market for some time (Table 4).

Table 4. Comparison of the Morse taper survival data percentages present in this study with the data of other researches

Author	Implant Platform	Survival	n (pacients)	n (Implants)	Follow-up
Machado et al. (present study)	Morse taper	98.39%	1,142	5,601	3 -11 years
Widmark et al.[32]	External Hexagon	98.4%	64	199	1 year
Malo et al.[3]	Internal Hexagon	98.1%	73	116	3 years
Mangano et al.[19]	Morse taper	98.4%	337	314	5 years
Mangano et al.[20]	Morse taper	97.56%	725	692	3 years
Mangano et al.[21]	Morse taper	98.49%	911	2549	5 years
Mangano et al.[22]	Morse taper	97.2%	49	178	10-20 years
Krebs et al.[33]	Morse taper	93.3%	4,206	12,737	5 years
Cassetta et al.[17]	Morse taper	94.1%	270	576	5 years

The geometry of the implant-abutment area seems to be a factor in influencing the transmission of stress and tension in the area around the implant. Nevertheless, according to the literature both non-conical and conical connection systems show comparable successful results, such as implant survival, absence of radiolucency around the implant in after 1-year, maximum bone resorption of 0.2 mm after 1 year, the absence of mobility of single-tooth implants, no signs of infection, pain, or any pathology in progress[14,15,17,32-34]. In the present study body and apex shape did not influence the survival rate of the dental implants, maybe it´s related to the adequate selection according to quality and quantity of bone available.

However, evidence demonstrates that Morse taper systems seem to be a better alternative in terms of bacterial sealing, resistance to abutment movement, improved biomechanics in relation to microgaps, more impediment to torque loss compared with other systems, as well as high resistance to fatigue and flexion[16,18,32].

In accordance with the data generated by this research, the macrodesign most used was cylindrical implants (70.33%) with the apex shape following the same dimensions. The diameter most commonly used was 3.5 mm (30.17%) and 3.75 mm (39.73%) with a mean length of between 11 mm (14.69%) and 13 mm (29.39%). This demonstrates a tendency to use implants with a smaller diameter more than in other research which used a diameter of 3.5 mm (78.60%) with a length of 11 mm[33]. The logistical regression analysis showed that body and apex shape designs and length, had no significant statistical influence on implant loss. Diameter significantly influenced the survival rate of the dental implants, which is not in accordance with a systematic review that reported that the survival rate of small-diameter implants appears to be similar to the regular ones[27].

Regarding immediate loading, 19.46% (1,090) of the implants were immediately loaded and of theses only 3 failed. Therefore, this study showed statistically significant difference and exemplifies that immediate loading, when well indicated and respecting all appropriate criteria and recommendations, could be beneficial for the maintenance of implant osseointegration. One of these recommendations is related to the final torque of the implants, of which, this study found evidence that a torque of 41- 50 Ncm (16.62%) as a mean torque was appropriate for immediate loading.

As this study only used information available from patient medical records, there could have been some bias in the results due to problems with inconsistencies in filling in the medical records and data interpretation of the same. Also, it was not possible to radiographically evaluate bone level in view of the non-standardization of the exams.

It is important to note that the data in this research was collected from an academic institution and that almost all the Implantology procedures were carried out by students with differing levels of apprenticeship.

CONCLUSION

It is possible to conclude that rehabilitation using Morse taper type platforms has a high survival rate, and that the variables: immediate loading, torque and diameter affected long-term stability. Implants from 3.5 mm to 4.0 mm in diameter and 8.0 mm to 11.0 mm in length were the most commonly used, which shows a tendency to use smaller implants.

REFERENCES

1. Brånemark P-I, Breine U, Adell R, Hansson BO, Lindström J, Ohlsson Å. Intra-osseous anchorage of dental prostheses: I. Experimental studies. Scand J Plast Reconstr Surg. 1969;3(2):81-100. http://dx.doi.org/10.3109/02844316909036699. PMid:4924041.

2. Aparicio C, Perales P, Rangert B. Tilted implants as an alternative to maxillary sinus grafting: a clinical, radiologic, and periotest study. Clin Implant Dent Relat Res. 2001;3(1):39-49. http://dx.doi.org/10.1111/j.1708-8208.2001.tb00127.x. PMid:11441542.

3. Malo P, de Araújo Nobre M, Lopes A, Moss SM, Molina GJ. A longitudinal study of the survival of All-on-4 implants in the mandible with up to 10 years of follow-up. J Am Dent Assoc. 2011 Mar;142(3):310-20. http://dx.doi.org/10.14219/jada.archive.2011.0170. PMid:21357865.

4. Levin L. Dealing with dental implant failures. J Appl Oral Sci. 2008 May-Jun;16(3):171-5. http://dx.doi.org/10.1590/S1678-77572008000300002. PMid:19089213.

5. Pye AD, Lockhart DE, Dawson MP, Murray CA, Smith AJ. A review of dental implants and infection. J Hosp Infect. 2009 Jun;72(2):104-10. http://dx.doi.org/10.1016/j.jhin.2009.02.010. PMid:19329223.

6. Haas R, Mailath-Pokorny G, Dortbudak O, Watzek G, Polak C, Furhauser R. A long-term follow-up of 76 Bränemark single-tooth implants. Clin Oral Implants Res. 2002 Feb;13(1):38-43. http://dx.doi.org/10.1034/j.1600-0501.2002.130104.x. PMid:12005143.

7. Duarte AR, Neto JP, Souza JC, Bonachela WC. Detorque evaluation of dental abutment screws after immersion in a fluoridated artificial saliva solution. J Prosthodont. 2013 Jun;22(4):275-81. http://dx.doi.org/10.1111/j.1532-849X.2012.00941.x. PMid:23107466.

8. Bacchi A, Regalin A, Bhering CL, Alessandretti R, Spazzin AO. Loosening torque of Universal Abutment screws after cyclic loading: influence of tightening technique and screw coating. J Adv Prosthodont. 2015 Oct;7(5):375-9. http://dx.doi.org/10.4047/jap.2015.7.5.375. PMid:26576253.

9. Arnetzl GV, Payer M, Falkensammer F, Arnetzl G. Effect of double conical abutment screw on implant preload. Clin Oral Implants Res. 2016 May;27(5):553-7. http://dx.doi.org/10.1111/clr.12623. PMid:26249208.

10. Ranieri R, Ferreira A, Souza E, Arcoverde J, Dametto F, Gade-Neto C, et al. The bacterial sealing capacity of morse taper implant-abutment systems in vitro. J Periodontol. 2015 May;86(5):696-702. http://dx.doi.org/10.1902/jop.2015.140623. PMid:25658884.

11. Coppedê AR, Bersani E, Mattos MG, Rodrigues RC, Sartori IA, Ribeiro RF. Fracture resistance of the implant-abutment connection in implants with internal hex and internal conical connections under oblique compressive loading: an in vitro study. Int J Prosthodont. 2009 May-Jun;22(3):283-6. PMid:19548411.

12. Hernigou P, Queinnec S, Flouzat Lachaniette CH. One hundred and fifty years of history of the Morse taper: from Stephen A. Morse in 1864 to complications related to modularity in hip arthroplasty. Int Orthop. 2013 Oct;37(10):2081-8. http://dx.doi.org/10.1007/s00264-013-1927-0. PMid:23715954.

13. Gil FJ, Herrero-Climent M, Lázaro P, Rios JV. Implant-abutment connections: influence of the design on the microgap and their fatigue and fracture behavior of dental implants. J Mater Sci Mater Med. 2014 Jul;25(7):1825-30. http://dx.doi.org/10.1007/s10856-014-5211-7. PMid:24719176.

14. Schmitt CM, Nogueira-Filho G, Tenenbaum HC, Lai JY, Brito C, Döring H, et al. Performance of conical abutment (Morse Taper) connection implants: a systematic review. J Biomed Mater Res A. 2014 Feb;102(2):552-74. http://dx.doi.org/10.1002/jbm.a.34709. PMid:23533139.

15. Macedo JP, Pereira J, Vahey BR, Henriques B, Benfatti CAM, Magini RS, et al. Morse taper dental implants and platform switching. The new paradigm in oral Implantology. Eur J Dent. 2016 Jan-Mar;10(1):148-54. http://dx.doi.org/10.4103/1305-7456.175677. PMid:27011755.

16. Scarano A, Valbonetti L, Degidi M, Pecci R, Piattelli A, de Oliveira PS, et al. Implant-abutment contact surfaces and microgap measurements of different implant connections under 3-dimensional x-ray microtomography. Implant Dent. 2016 Oct;25(5):656-62. http://dx.doi.org/10.1097/ID.0000000000000465. PMid:27551879.

17. Cassetta M, Di Mambro A, Giansanti M, Brandetti G, Calasso S. A 36-month follow-up prospective cohort study on peri-implant bone loss of Morse Taper connection implants with platform switching. J Oral Sci. 2016;58(1):49-57. http://dx.doi.org/10.2334/josnusd.58.49. PMid:27021540.

18. Lima de Andrade C, Carvalho M, Del Bel Cury A, Sotto-Maior B. Biomechanical effect of prosthetic connection and implant body shape in low quality bone of maxillary posterior single-implant supported restorations. Int J Oral Maxillofac Implants. 2016 Jul-Aug;31(4):e92-7. http://dx.doi.org/10.11607/jomi.4133. PMid:27447166.

19. Mangano C, Mangano F, Piatelli A, Lezzi G, Mangano A, La Colla L, et al. Single-tooth Morse taper connection implants after 1 year of functional loading: a multicentre study on 302patients. Eur J Oral Implantology. 2008;1(4):305-15. PMid:20467637.

20. Mangano C, Mangano F, Piattelli A, Iezzi G, Mangano A, La Colla L. Prospective clinical evaluation of 1920 Morse taper connection implants: results after 4 years of functional loading. Clin Oral Implants Res. 2009 Mar;20(3):254-61. http://dx.doi.org/10.1111/j.1600-0501.2008.01649.x. PMid:19397637.

21. Mangano C, Mangano F, Shibli JA, Tettamanti L, Figliuzzi M, d'Avila S, et al. Prospective evaluation of 2,549 Morse taper connection implants: 1- to 6-year data. J Periodontol. 2011 Jan;82(1):52-61. http://dx.doi.org/10.1902/jop.2010.100243. PMid:20653436.

22. Mangano C, Iaculli F, Piattelli A, Mangano F. Fixed restorations supported by Morse-taper connection implants: a retrospective clinical study with 10-20 years of follow-up. Clin Oral Implants Res. 2015 Oct;26(10):1229-36. http://dx.doi.org/10.1111/clr.12439. PMid:24954285.

23. Lazzara RJ, Porter SS. Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels. Int J Periodontics Restorative Dent. 2006 Feb;26(1):9-17. PMid:16515092.

24. Berglundh T, Abrahamsson I, Lindhe J. Bone reactions to longstanding functional load at implants: an experimental study in dogs. J Clin Periodontol. 2005 Sep;32(9):925-32. http://dx.doi.org/10.1111/j.1600-051X.2005.00747.x. PMid:16104954.

25. Canullo L, Rasperini G. Preservation of peri-implant soft and hard tissues using platform switching of implants placed in immediate extraction sockets: a proof-of-concept study with 12- to 36-month follow-up. Int J Oral Maxillofac Implants. 2007 Nov-Dec;22(6):995-1000. PMid:18271382.

26. Mijiritsky E, Mazor Z, Lorean A, Levin L. Implant diameter and length influence on survival: Interim results during the first 2 years of function of implants by a single manufacturer. Implant Dent. 2013 Aug;22(4):394-8. http://dx.doi.org/10.1097/ID.0b013e31829afac0. PMid:23811719.

27. Sohrabi K, Mushantat A, Esfandiari S, Feine J. How successful are small-diameter implants? A literature review. Clin Oral Implants Res. 2012 May;23(5):515-25. http://dx.doi.org/10.1111/j.1600-0501.2011.02410.x. PMid:22313216.

28. Olate S, Lyrio MC, de Moraes M, Mazzonetto R, Moreira RW. Influence of diameter and length of implant on early dental implant failure. J Oral Maxillofac Surg. 2010 Feb;68(2):414-9. http://dx.doi.org/10.1016/j.joms.2009.10.002. PMid:20116716.

29. Goiato MC, dos Santos DM, Santiago JF Jr, Moreno A, Pellizzer EP. Longevity of dental implants in type IV bone: a systematic review. Int J Oral Maxillofac Surg. 2014 Sep;43(9):1108-16. http://dx.doi.org/10.1016/j.ijom.2014.02.016. PMid:24679842.

30. Turkyilmaz I, Aksoy U, McGlumphy EA. Two alternative surgical techniques for enhancing primary implant stability in the posterior maxilla: a clinical study including bone density, insertion torque, and resonance frequency analysis data. Clin Implant Dent Relat Res. 2008 Dec;10(4):231-7. http://dx.doi.org/10.1111/j.1708-8208.2008.00084.x. PMid:18384409.

31. Moraschini V, Poubel LA, Ferreira VF, Barboza ES. Evaluation of survival and success rates of dental implants reported in longitudinal studies with a follow-up period of at least 10 years: a systematic review. Int J Oral Maxillofac Surg. 2015 Mar;44(3):377-88. http://dx.doi.org/10.1016/j.ijom.2014.10.023. PMid:25467739.

32. Widmark G, Friberg B, Johansson B, Sindet-Pedersen S, Taylor A. Mk III: a third generation of the self-tapping Brånemark system implant, including the new Stargrip internal grip design. A 1-year prospective four-center study. Clin Implant Dent Relat Res. 2003;5(4):273-9. http://dx.doi.org/10.1111/j.1708-8208.2003.tb00211.x. PMid:15127999.

33. Krebs M, Schmenger K, Neumann K, Weigl P, Moser W, Nentwig GH. Long-term evaluation of ANKYLOS® dental implants, part I: 20-year life table analysis of a longitudinal study of more than 12,500 implants. Clin Implant Dent Relat Res. 2015 Jan;17(Suppl 1):e275-86. http://dx.doi.org/10.1111/cid.12154. PMid:24103113.

34. Liu Y, Wang J. Influences of microgap and micromotion of implant-abutment interface on marginal bone loss around implant neck. Arch Oral Biol. 2017 Nov;83:153-60. http://dx.doi.org/10.1016/j.archoralbio.2017.07.022. PMid:28780384.

CONFLICTS OF INTERESTS

The authors Ana Claudia Moreira Melo and Rafael Coutinho declare no conflicts of interest. Geninho Thomé and Sergio Bernardes are directly related to the company that fabricates the implants that composed the sample (Neodent).

*CORRESPONDING AUTHOR

Ana Claudia Moreira Melo, Rua Jacarezinho, 658, Merces, 80710-150 Curitiba - PR, Brasil, e-mail: amelo@ilapeo.com.br; anacmmelo@gmail.com

Received: July 4, 2019
Accepted: October 17, 2019